7TH GRADE CURRICULUM

7TH GRADE CURRICULUM OUTLINE
TRANSPORTATION MODULE

Lesson I: 7th grade

Transportation and Energy Use: Powershift DVD and Discussion

- Watch Powershift DVD
- Class discussion about the video and personal views on global energy use issues and renewable energy ideas.

Lesson 2: 7th grade

Transportation: Trains, Planes, and Automobiles. . .and Bikes and Boats

- Brainstorming session
- Create word maps: different modes of transportation
- 2-minute transportation slide show

Lesson 3: 7th grade

Transportation through Time: Creating A Transportation Timeline

- Brainstorming session
- Creating a transportation timeline

Resources:

DK Visual Timeline of Transportation, Anthony Wilson, 1995, ISBN# 1-56458-880-7

Lesson 4: 7th Grade

Investigating Transportation: A Small Group Research Project

- Part #1: Begin history of transportation research project
- Discussion and exercises on how to participate in effective small group projects

Lesson 5: 7th Grade

Investigating Transportation: A Small Group Research Project

- Part #2: Discuss challenges, obstacles, questions

Lesson 6: 7th grade

Investigating Transportation: A Small Group Research Project

- Part #3: Presentations and discussion

Lesson 7: 7th grade

A Cursory Glance: Gasoline Production

- Class reading & discussion lecture / note-taking assignment

Lesson 8: 7th grade

A Cursory Glance: The Four-Stroke Internal Combustion Engine

- The history of the combustion engine
- How do they work
- Comubustion chemistry
- Drawing combustion engines
- Teacher-led demonstration: potato rockets

Lesson 9: 7th grade

Automobile emissions and pollutants, and global warming

- Reading and discussion about global warming
- Discuss the automobile's role in global warming

Lesson 10: 7th grade

Creating Change: Personal Decision-making and Automobiles

- U.S. driving habits and gasoline consumption: analysis and calculations
- Hybrid vehicle technology: reading and discussion
- Understanding feedback loops–global warming and the impacts of personal decision-making

Lesson 1: 7th grade
Transportation and Energy Use: Powershift Video and Discussion

Lesson Overview: Exploring global energy impacts.
Lesson Concept: All life is connected throughout the world. We share a world of finite resources with a variety of beings and though we profess to have widely varying needs, our most primary needs are quite similar–water, food, and shelter.

Materials:
- Note-taking journals
- Pencils
- Erasers
- Powershift video (26 minutes)

Standards:
- English:
  - IX.11.MS.1 (Inquiry and Research: Define and investigate important issues and problems using a variety of resources).
- Science:
  - I.1.MS.1 (Construct new Scientific and personal Knowledge: Generate scientific questions about the world based on observation).
  - II.1.MS.3 (Reflect on the Nature, Adequacy and Connections Across Scientific Knowledge: Show how common themes of science, mathematics, and technology apply in real-world contexts).
- Social Studies:
  - II.3.MS.4 (Geographic Perspective: Describe the major economic and political connections between the United States and different world regions and explain their causes and consequences).
  - II.5.MS.1 (Geographic Perspective: Describe how social and scientific changes in regions may have global consequences).
  - IV.2.MS.4 (Economic Perspective: Examine the historical and contemporary role an industry has played and continues to play in a community).
  - VI.1.MS.3 (Public Discourse and Decision Making: Explain how culture and experiences shape positions that people take on an issue).

Timeline: 1 class period (50 - 60 minutes) depending on the length of each presentation

Class Structure: watch a DVD and class discussion

Assessment Strategy: Pre-module Assessment Questions #1, 2, & 3
EEK! Daily Assessment

Lesson 1: 7th grade
Transportation and Energy Use: Powershift Video and Discussion

Lesson Overview: Exploring global energy impacts.
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Materials:

- Note-taking journals
- Pencils
- Erasers
- Powershift video (26 minutes)

CLASS EXERCISES:

I. Introducing the Module

This short video introduces how energy impacts our daily lives and, most importantly, discusses how our everyday actions impact not only in our local communities, but create impacts around the globe.

We have chosen this video as an introduction to the module to stress a main point of this curriculum: global interconnectedness. The decisions we make affect the world. Just as, the decisions of others around the world affect us likewise. We live within a global community.

II. Before the Video

Ask the students to answer the following questions in their note-taking journals dedicated for this module. Possible responses are in red.

1. How do you use energy (electricity, gas) in your daily life?

Lighting, refrigerator, freezer, toaster, stove, automobile (gasoline).

2. What is the primary source of energy in the United States?

Approximately 60% of all electricity in the United States is generated from burning coal.

3. Do you think the amount of energy you use can affect people living in different countries? How might this happen?

We live in a global community where our actions affect those around the world. Specific examples include: our CO_2 emissions and other pollutant emissions which contribute to acid rain, and global warming.

III. After the Video

With the time remaining during class, begin a class discussion about the video. The following questions may be helpful to stimulate conversation.

- What did you learn that you had not thought of before?
- Do you believe that many of your actions affect others around the world?
- What could you do in your own life to reduce the impact on the environment?
- How or why could these changes be difficult?
- What would help you to stand by these changes?

IV. Post-video Writing

Have the students update their responses to the questions they answered prior to watching the video and include any thoughts / conversation points from the post-video discussion.

V. Further Discussions

If the class desires to continue the conversation, create small groups and ask each group to brainstorm three questions:

1. What was the most significant they learned in the video they did not know before?
2. What could they do in their own life to reduce their impact on the environment?
3. How or why could they foresee question #2 being difficult to enact?

Lesson 2: 7th grade
Transportation: Trains, Planes, and Automobiles. . .and Bikes and Boats

Lesson Overview: Create a word map to explore ideas about transportation–past and present.
Lesson Concept: There are multiple ways to transport people and goods throughout the world. Investigate the potential connections of how transportation can affect all aspects of life.

Materials:
- Large white paper for note-taking
- Student Hand-out: Ground Rules for Conversation & Brainstorming

Standards:
- English:
  - IX.11.MS.1 (Inquiry and Research: Generate questions about important issues that affect them or topics about which they are curious; narrow the questions to a clear focus; and, create a thesis or a hypothesis).
- Science:
  - II.1.MS.3 (Reflect on the Nature, Adequacy and Connections Across Scientific Knowledge: Show how common themes of science, mathematics, and technology apply in real-world contexts).
- Social Studies:
  - II.5.MS.1 (Geographic Perspective: Describe how social and scientific changes in regions may have global consequences).
  - IV.2.MS.2 (Economic Perspectives: Compare various methods for the production and distribution of goods and services).
  - IV.2.MS.4 (Economic Perspective: Examine the historical and contemporary role an industry has played and continues to play in a community).

Timeline: 1 class period (50 - 60 minutes)

Class Structure: whole class brainstorming and discussion

Assessment Strategy: EEK! Daily Assessment
General Assessment Strategy #1
General Assessment Strategy #3

Lesson 2: 7th grade
Transportation: Trains, Planes, and Automobiles. . .and Bikes and Boats

After watching the Powershift DVD introducing a perspective on global energy issues, the following lessons will focus on gaining knowledge and sharing viewpoints surrounding transportation.

This lesson is primarily a brainstorming session devoted to exploring the students' ideas and understanding about transporting people and goods throughout the world. As always, it is important to begin teaching a lesson from where the students are–begin with their inherent knowledge and work from there. This lesson includes a series of questions as well as background material to facilitate discussions.

Lesson Overview: Class discussion to explore different thoughts and understanding about transportation–past and present.
Lesson Concept: There are multiple ways to transport people and goods throughout the world. Investigate the potential connections of how transportation can affect all aspects of life.

Materials:
- Large white paper for note-taking
- Student Hand-out: Ground Rules for Conversation & Brainstorming

CLASS EXERCISES:

I. Transportation Word Map

In this first exercise, the goal is to encourage conversation and a free-flow of ideas about transportation to begin percolating within the classroom. In order to facilitate a brainstorming session with the students, create a word-map and see what connections the students begin making about transportation and the effects it has on all living things.

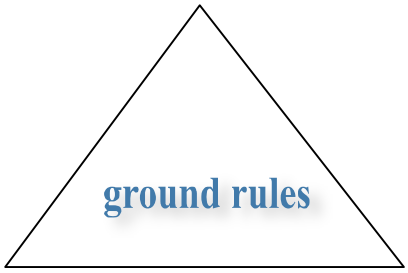
During this first exercise, it is important to remember the Ground Rules for conversation and respect not only everyone's ideas, but also their silence.

We are suggesting creating the word map on a large piece of butcher paper that you can save and refer to later. This initial word map will serve as a crucial guide for the entire Transportation Module and will provide the following:
- Tool for discovering the students' prior knowledge
- Starting point for teaching and learning (may show how deeply the students have thought about the idea of transportation)
- Tool for discovering what the students view as important
- Assessment tool as the Module progresses (the initial word map can be added to or a new one created as the increase their knowledge
- Teaching tool (use language of the students to help them 'make sense' of the lessons)

II. Ground Rules for Conversation & Brainstorming

These ground rules apply for the whole class–students, teachers, visitors–when engaged in conversations and teasing out ideas (brainstorming).

Trust
‡Respect each others' personal style
‡Don't make fun of anyone
‡Keep an open mind



Communication
‡Speak clearly
‡Stay focused
‡Answer questions directly and stay on topic
‡Wait your turn

Responsibility
‡Pay close attention
‡Ask informed questions
‡Include all group members

III. Creating the Word-Map

- Write the word transportation on the board. The word may conjure many different ideas–cars, trains, people, food, pollution, technology, auto-industry, jobs, unions, lay-offs, economy, businesses. Word maps can often become quite elaborate–encourage the students to explore as many topics as possible within the word map to make connections between:
    - humans
    - non-humans
    - industry
    - pollution
    - jobs
    - quality of life issues

- But, when first introducing word mapping as a brainstorming exercise with your students, introduce the concept step-by-step. The following diagrams will take you through the beginning steps of what a word map might look like and provide ways to introduce ideas and ask questions.

- Look around the room and ask the students, "OK, let's begin with different modes of transportation–let's see how many modes we can think of."

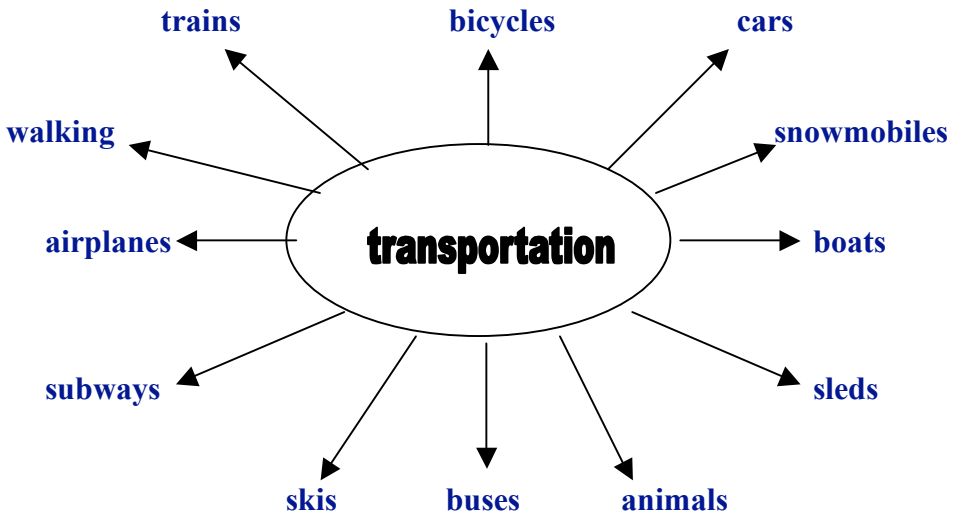
- Write each word or phrase on the board around it. When one thought directly leads to another, follow the thought pattern with arrows. The following example is of a simple word map.

Transportation Word Map Example
Step 1: Different Modes of Transportation

Step 1: Hang a large piece of white butcher paper on the board or wall.
Step 2: Write the word 'transportation' on the middle of the paper.
Step 3: Ask the students to brainstorm about every different mode of transportation they can think of. Write down all of their responses.

The word map below is an example of how your word map might look:

Note: Please remember there is no 'right' or 'wrong' way to create a word map–this is a brainstorming exercise. The intent is to gather as many ideas as possible about what the students perceive as different modes of transportation.



Transportation Word Map Example
Step 2: Mining the Ideas

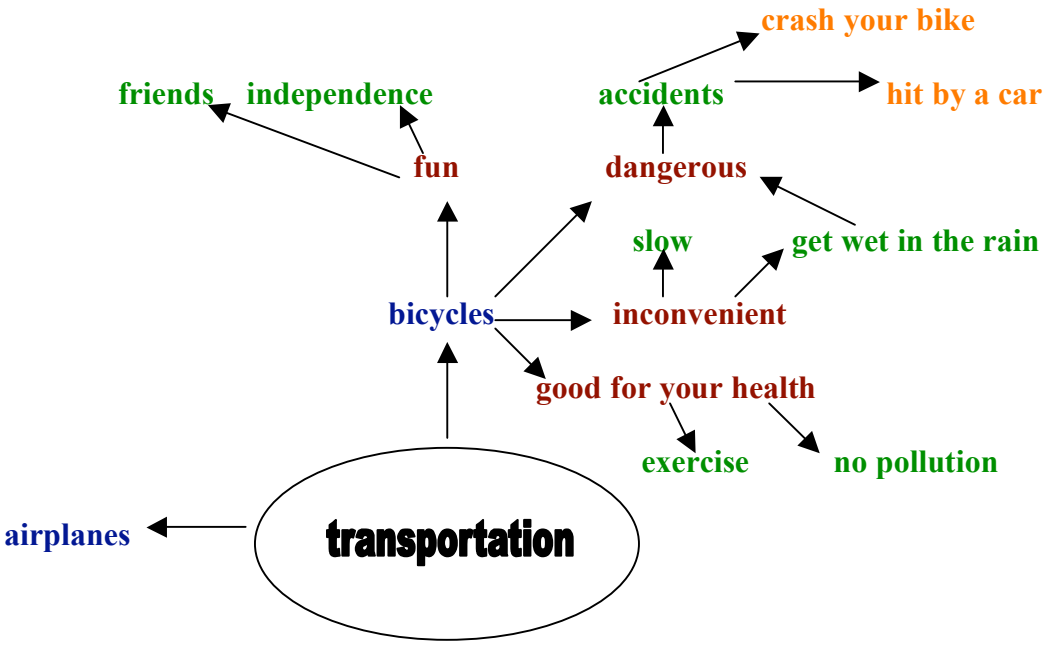
Once the class has compiled all of the different modes of transportation that they can imagine, the next step is to continue the brainstorming session by investigating each idea.

In this step, encourage the students to 'free-associate' ideas for each mode of transportation. It might be helpful, though, to have the students focus on one mode at a time for Step 2. Below is an example of what the word map may look like when mining 'bicycles'.

Understanding the example word map: Tiers of Investigation

The 1st tier of investigation = a mode of transportation (bicycles, airplanes)
The 2nd tier of investigation = first things that came to mind (inconvenient, dangerous, fun, good for your health)
The 3rd tier of investigation = brainstorming the 2nd tier (friends, independence, accidents, slow, get wet in the rain, exercise, no pollution) **
**But, note that there is a connection made between 'get wet in the rain' and 'dangerous'
The 4th tier of investigation = brainstorming the 3rd tier (crash your bike, hit by a car)

Step 1: Choose one mode of transportation at a time to 'mine'.
Step 2: Ask the students, "What comes to mind about x mode of transportation?" Write down all of their responses.

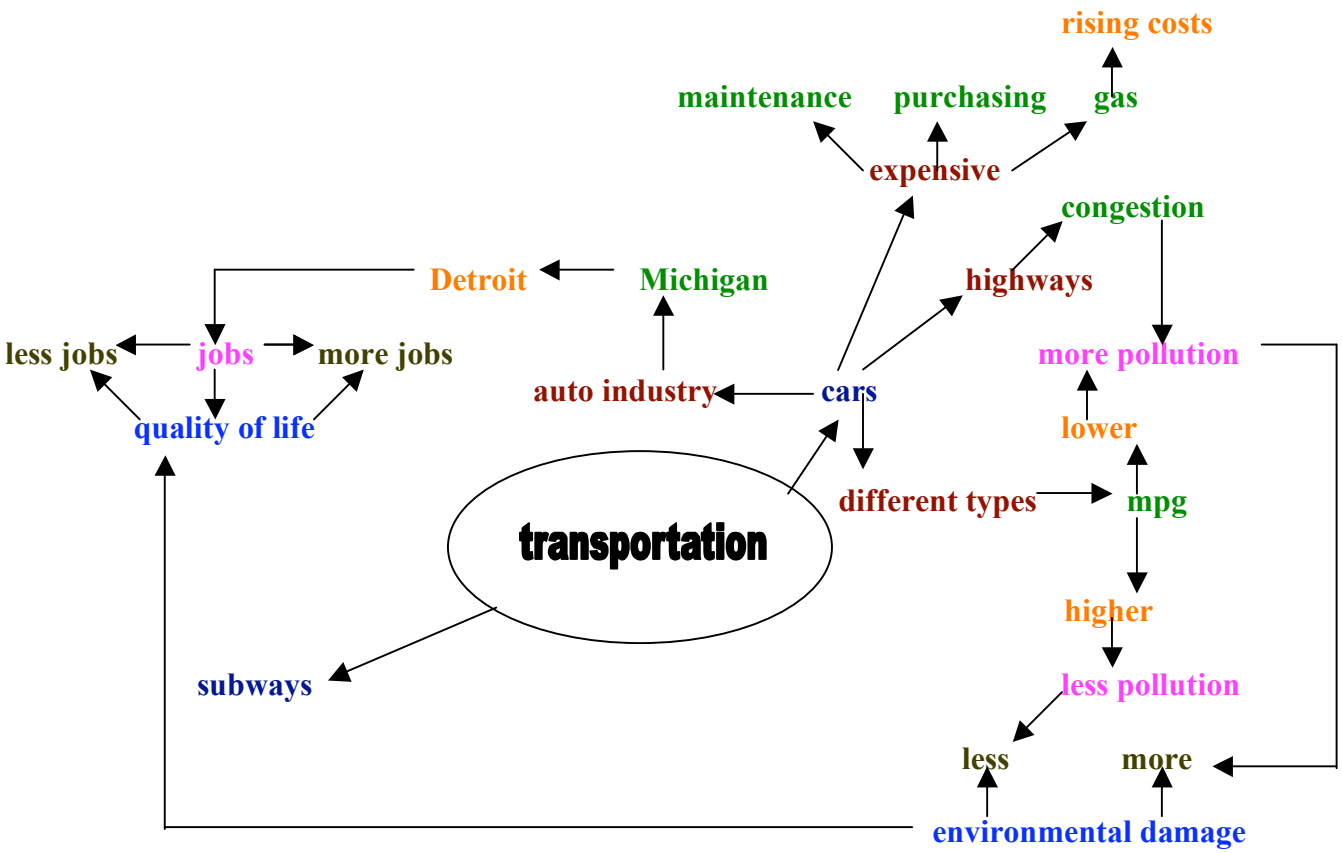


Transportation Word Map Example
Step 3: Mining the Ideas #2

The following is another example–in this example, we word map 'cars'. This word map is becoming more complex with deeper tiers of investigation, but the investigation is just beginning to delve into the connections of how 'cars' may affect all aspects of life.

Additional Tiers of Investigation:

The 5th tier of investigation = brainstorming the 4th tier (more pollution, jobs)
The 6th tier of investigation = brainstorming the 5th tier (environmental damage, quality of life)**
It is essentially within the 6th tier that making deeper connections across different headings takes place. For example, the state of the environment also directly relates to quality of life issues.
7th tier of investigation = brainstorming the 6th tier (less jobs, more jobs, less, more (environmental damage).



Teacher's Notes:

Additional Assessment Strategy

If you need to establish pre and post student knowledge of content material for this unit, these initial word maps can act as a descriptive pre-test material to gauge the students' prior knowledge.

Student Hand-out: Ground Rules for Conversation & Brainstorming

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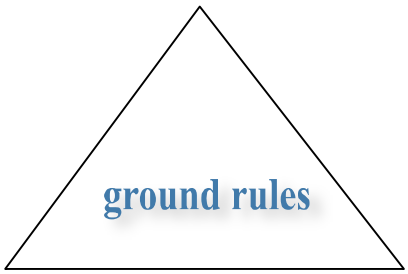
‡Don't make fun of anyone
‡Keep an open mind



Communication
‡Speak clearly
‡Stay focused
‡Answer questions directly and stay on topic
‡Wait your turn

Responsibility
‡Pay close attention
‡Ask informed questions
‡Include all group members

Lesson 3: 7th grade
Transportation through Time: Creating A Transportation Timeline

Lesson Overview: Exploring how transportation has changed over time.
Lesson Concept: People have been transporting materials for many years in many different ways around the world.

Materials:
- 18 x 24 white construction paper (to create the class composite timeline)
- tape
- Student Hand-out #1: Transportation Timeline (optional at the end of the lesson)
- Student Hand-out #2: Ground Rules for Conversation & Brainstorming
- 2-minute Modern Modes of Transportation slideshow

Standards:
- English:
  - IX.11.MS.1 (Inquiry and Research: Define and investigate important issues and problems using a variety of resources).
- Science:
  - I.1.MS.1 (Construct new Scientific and personal Knowledge: Generate scientific questions about the world based on observation).
  - II.1.MS.3 (Reflect on the Nature, Adequacy and Connections Across Scientific Knowledge: Show how common themes of science, mathematics, and technology apply in real-world contexts).
- Social Studies:
  - IV.2.MS.4 (Economic Perspective: Examine the historical and contemporary role an industry has played and continues to play in a community).
  - VI.1.MS.3 (Public Discourse and Decision Making: Explain how culture and experiences shape positions that people take on an issue).

Timeline: 1 – 2 class periods (50 - 60 minutes each)

Class Structure: small group brainstorming and discussion

Assessment Strategy: EEK! Daily Assessment
General Assessment Strategy #1
General Assessment Strategy #3

Lesson 3: 7th grade
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Materials:

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- Student Hand-out #1: Transportation Timeline (optional at the end of the lesson)
- Student Hand-out #2: Ground Rules for Conversation & Brainstorming
- 2-minute Modern Modes of Transportation slideshow

CLASS EXERCISES:

I. Modern Modes of Transportation Slideshow

Begin the lesson by showing the 2-minute slideshow of different forms of transportation–to move people and goods–throughout the world today.

II. Creating the Transportation Timeline: Small Group Brainstorming Session

The goal of this exercise is to have the students create a group timeline roughly plotting the dates and times of a History of Transportation. At this point, all information should be exclusively the students' prior knowledge (no research allowed).

The Ground Rules for the Transportation Timeline

Ask the students: "When might these things have happened in the past?"

- The year when humans first began transporting goods
- Name a present-day mode of transportation
- The years and events of at least 8 modes of transportation in between
- The goal is to write 10 things with dates on their timeline.
- Share with the class. This is a brainstorming exercise!

III. Compiling the Ideas

After the small groups have completed their Timeline drafts, facilitate a whole class discussion. Then, create a class Timeline on the construction paper. Write one event per piece of paper and then hang, in sequence, around the room to create a class rough-draft timeline.
Below are few starter questions to jumpstart the whole class conversation:

- What do you believe was the first mode of transportation?
- What do you believe might be the first object that was transported?
- Approximately when did this (the above ideas) take place?

Teacher's Note: Continue in this mode, beginning your questions with phrases such as, "What might have happened. . ." or "What do you believe could have taken place. . ." This type of language can help facilitate a safe environment for brainstorming sessions. The goal of this exercise is not necessarily to discover the "correct" answers, but to encourage trusting dialogue between the students. Once this atmosphere occurs within the lesson, the student will be better able to use the sum of their collective knowledge to tease out the rough dates of the Timeline.

IV. Sharing the Compilation Timeline

In order to facilitate "filling in the gaps"–if they exist–within the Transportation Timeline, please refer to the cursory compilation provided. Also, it is best of offer this Timeline to the students AFTER they create their own Transportation Timelines to help assess the students' prior knowledge and brainstorming abilities.

Background Information:

Transportation Timeline Note*

This timeline has been compiled from a variety of sources and is cursory at best. There is much debate over the invention of some modes of transportation–such as what is technically considered the first bicycle–but, we have attempted to provide a brief account of the generally accepted inventors and dates for the following history of transportation invention highlights.

For further detailed information, please refer to the *Visual Timeline of Transportation* by Anthony Wilson, 1995, Dorling Kindersley.

A Brief Glance at the History of Transportation*

8000 BC Archeologists believe logs were used as rollers to move large sledges (boxes) in Asia.

3500 BC Archeologists believe the first wheels were used by Mesopotamian potters as pottery wheels not for transportation.

3200 BC The oldest wheel used for transportation discovered by archeologists was found in Mesopotamia. It is believed that the first wheels used for transportation pulled Mesopotamian chariots.

3000 BC Egyptians and Mesopotamians use boats extensively for travel.

181-234 The wheelbarrow is invented and used in China. Chuko Liang is generally considered the inventor of the first wheelbarrow that was used for a large-scale application. He was an advisor to the Shu-Han Dynasty and developed the wheelbarrow for military transport.

1492 Leonardo da Vinci (1452- 1519) creates over 100 drawings detailing ideas, theories about flight and constructing flying machines. (Sketches for bicycles have also been found among da Vinci's sketch books).

1783 First manned hot air balloon takes flight in Paris–invented by the Montgolfier brothers.

1787 Passenger carrying steamboat invented by John Fitch.

1814 Steam powered railroad locomotive invented by George Stephenson in England.

1834 Thomas Davenport invents the first battery powered electric car.

1839 Modern bicycles invented (with pedals and steering) by Kirkpatrick Macmillan in Scotland.

1860 Gasoline internal combustion engine created and produced en masse by Jean Lenoire (Belgium).

1863 The World's first subway system opens in London.

1876 Four-stroke internal combustion engine invented by Nicolaus Otto of Germany.

1877 The first San Francisco cable cars go into service.

1885 Gas powered motorcycle invented by Gottlieb Daimler in Germany. (Daimler was an employee of Otto's when he built the 4-stroke internal combustion engine).

1885 Three-wheeled automobile with an internal combustion engine built by Karl Benz of Germany.

1898 Dr. Ferdinand Porsche of Germany builds a hybrid car using an internal combustion engine to spin a generator that provided power to electric motors located in the wheel hubs.

1903 The Wright brothers pilot the first powered, sustained airplane flight at Kitty Hawk in North Carolina.

1908 Henry Ford streamlines automobile assembly line manufacturing and begins mass-producing the Model T.

1935 The first manned and un-tethered helicopter flight successfully completed by Frenchmen Louis Bergreut and Rene Dorand.

1947 First supersonic jet flights (non-passenger).

1964 The first Bullet Train begins passenger service in Japan.

1969 First manned space flight to land on the Moon (the Apollo 11 flight).

1970 First passenger jumbo jet (Boeing 747) flight.

1997 Toyota Prius hybrid cars for sale to the public in Japan.

1999 Honda releases the first mass marketed hybrid car in the United States, the four-door Honda Insight.

2000 The first four-door, sedan-style, hybrid vehicle available in the United States–the Toyota Prius.

2004 The Toyota Prius II won the 2004 Car of the Year Award from Motor Trend magazine and the North American Auto Show. Toyota increases the production of Prius for the U.S. market to 47,000. Interested buyers wait up to six months to purchase a Prius.

2004 Ford releases the Ford Escape–the first American hybrid vehicle and the first hybrid SUV.

Student Hand-out #1: Timeline

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Student Hand-out #2: Ground Rules for Conversation & Brainstorming

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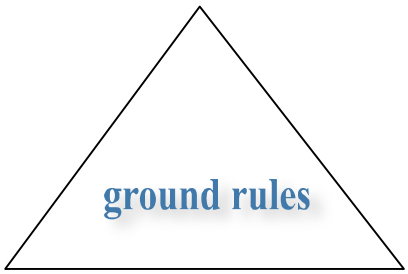

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‡Wait your turn

Responsibility
‡Pay close attention
‡Ask informed questions
‡Include all group members

Additional Resource: Transportation Slideshow

As part of this curriculum, we have compiled a 2-minute transportation slideshow showing a variety of modern-day modes of transportation. You can find this slideshow on the CD under 'Transportation Slideshow'. This slideshow was created on a Mac, system 10.4 Tiger, in the program IPhoto.

The credits for the slideshow are below.

2-Minute Slide Show Credits

1. Eurostar at Ashford, Photographer Ian Britton
   www.freefoto.com/preview.jsp?id=25-06-7

2. Bike riding, London, Photographer Ian Britton
   www.freefoto.com/preview.jsp?id=21-02-32&k=Cycleing

3. Traffic Congestion with trucks, A1 Gateshead Western Bypass, Photographer Ian Britton
   www.freefoto.com/preview.jsp?id=21-292&k=Rush+hour+on+the+A1+Gateshead+Western+Bypass

4. Airplane, Boeing 747, Photographer Ian Britton
   www.freefoto.com/preview.jsp?id=2051-14-8&k=Boeing+747

5. Scooter Riding, Photographer Ian Britton
   www.freefoto.com/preview.jsp?id=21-12-53&k=Motorbike

6. Barge Piz Boval, Rhine River, Switzerland, Photographer Ian Britton
   www.freefoto.com/preview.jsp?id=2026-35-8&k=Barge+Piz+Boval%2C+River+Rhine%2C+Basel%2C+Switzerland

7. The Trik, Oslo Norway, Photographer D Jones, SFG
   sustainablefutures@hotmail.com

8. Scooters, Kaohsiung Tawain, Photographer Harold Glasser, SFG
   sustainablefutures@hotmail.com

9. Bike Park, London, Photographer Ian Britton
   www.freefoto.com/preview.jsp?id=21-02-36&k=Bicycles

10. Fishing Boats, Photographer Ian Britton
    www.freefoto.com/preview.jsp?id=2026-31-3

11. Bike Delivery, Norths Bakery, Photographer Ian Britton
    www.freefoto.com/preview.jsp?id=21-02-12&k=Bicycles

12. Coach USA Bus, Photographer Ian Britton
    www.freefoto.com/preview.jsp?id=2030-01-5&k=Coach+USA+Bus

13. P&O Pride of Le Harve Ferry, Photographer Ian Britton
    www.freefoto.com/preview.jsp?id=2026-05-6&k=P%26O+Pride+of+Le+Harve+Ferry

14. SMART Car Showroom, Photographer Harold Glasser, SFG
sustainablefutures@hotmail.com

15. The World Expo in Aichi, Japan, Photographer Harold Glasser, SFG
sustainablefutures@hotmail.com

16. Yellow School Bus, Photographer Ian Britton
www.freefoto.com/preview.jsp?id=2030-02-4&k=Yellow+School+Bus

17. Family hiking in the Eastern Sierra mountains, CA, Photographer D Jones, SFG
sustainablefutures@hotmail.com

18. NY Taxis, Photographer, Ian Britton
www.freefoto.com/preview.jsp?id=21-41-12&k=New+York+City+Taxi+Cabs

19. Sailing River Solent, Photographer Ian Britton
www.freefoto.com/preview.jsp?id=2026-22-57&k=Sailing%2C+River+Solent

20. Scooters in Kaohsiung, Taiwan, Photographer Harold Glasser, SFG
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21. Bike Riding, Photographer Ian Britton
www.freefoto.com/preview.jsp?id=21-83-96&k=Cycling

22. Manchester Airport, Photographer Ian Britton
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23. SMART cars on the road in Taiwan, Photographer Harold Glasser, SFG
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24. Tall Ship 2005 Race Newcastle Gateshead, Photographer Ian Britton,
www.freefoto.com/preview.jsp?id=2026-51-34&k=Tall+Ships+2005+Newcastle+Gateshead

25. Scooter riding in Taiwan, Photographer Harold Glasser, SFG
sustainablefutures@hotmail.com

26. Cycleways in the Netherlands, Hanseroute and Maasroute, Photographer bzh
www.virtualtourist.com/travel/Europe/Netherlands/Provincie_Noord_Holland/Amsterdam-463377/Transportation-Amsterdam-TG-C-1.html

27. Punting The Backs, Cambridge, London, Photographer Ian Britton,
www.freefoto.com/preview.jsp?id=2026-10-52&k=Punting%2C+The+Backs%2C+Cambridge

28. Taiwanese neighborhood, Photographer Harold Glasser, SFG
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29. Starlight Amtrak Train Service
www.trainweb.org/amtrakphotos/

30. Airbus 320, Photographer Ian Britton
www.freefoto.com/preview.jsp?id=20-01-1

Lesson 4: 7th grade
Investigating Transportation: A Small Group Research Project
Step 1: Effective Small Group Projects

Lesson Overview: Exploring how transportation has changed over time.
Lesson Concept: People have been transporting materials for many years in many different ways around the world.

Materials:
- Word map from Lesson 1
- Transportation Timeline from Lesson 2
- Student Hand-out #1: 5 Goals
- Student Hand-out #2: Ground Rules for Effective Small Group Projects
- Note-taking journals

Standards
- English:
  - IX.11.MS.1 (Inquiry and Research: Define and investigate important issues and problems using a variety of resources).
- Science:
  - I.1.MS.1 (Construct new Scientific and personal Knowledge: Generate scientific questions about the world based on observation).
  - II.1.MS.3 (Reflect on the Nature, Adequacy and Connections Across Scientific Knowledge: Show how common themes of science, mathematics, and technology apply in real-world contexts).
- Social Studies:
  - II.5.MS.1 (Geographic Perspective: Describe how social and scientific changes in regions may have global consequences).
  - IV.2.MS.4 (Economic Perspective: Examine the historical and contemporary role an industry has played and continues to play in a community).
  - VI.1.MS.3 (Public Discourse and Decision Making: Explain how culture and experiences shape positions that people take on an issue).

Timeline: 2 – 5 class periods (50 - 60 minutes each) depending on available resources within the classroom / school and the students' access to out-of-class research resources

Class Structure: small group project

Assessment Strategy: EEK! Daily Assessment
General Assessment Strategy #1
General Assessment Strategy #3

Lesson 4: 7th grade
Investigating Transportation: A Small Group Research Project
Step 1: Effective Small Group Projects

Lesson Overview: Exploring how transportation has changed over time.
Lesson Concept: People have been transporting materials for many years in many different ways around the world.

Materials:
- Word map from Lesson 1
- Transportation Timeline from Lesson 2
- Student Hand-out #1: 5 Goals
- Student Hand-out #2: Ground Rules for Effective Small Group Projects
- Note-taking journals

CLASS EXERCISES:

I. Choosing the Topic

For their research topic, have each small group choose:
- 1 mode of transportation from the word map
  and
- 1 time period from the timeline

for example: Bicycles from 1839 to 1979

II. Focusing the Topic

Below are three suggested questions for the small groups to answer and include as a minimum within their research project:

1. How did the mode of transportation change over your selected time period (expanded, decreased, became more efficient or less efficient, became more expensive or less expensive, became more popular or outdated, etc.).

2. How is your chosen mode of transportation being used today or is it obsolete? In what parts of the world is the transportation being used?

3. How do you feel about the mode of transportation? Do you believe it should be increased, decreased, changed, re-designed, etc. in the world today? (Please be persuasive in your answer.)

4. Provide one visual–a drawing, photo, or sculpture–of your chosen mode of transportation at the beginning of your time period.

5. Provide one visual–a drawing, photo, or sculpture–of your chosen mode of transportation at the end of your time period.

Effective Small Group Research Projects

Teacher's Note: You may already have effective ground rules established within your classroom for facilitating small group projects. In an attempt to strengthen the students' relationships and to assist teachers in teaching small group skills, we have compiled a few suggestions below to assist your students in successfully navigating working together successfully and respectfully.

I. A Few Goals

One goal of small group projects is to encourage and promote self-regulating behavior in the students and vis-à-vis in the class as a whole. In the best-case scenario, small group work will aid students in improving the following skills:

- How to identify, clarify, explore, and solve problems
- Promote critical thinking skills and maximize learning for all
- Build trusting relationships
- Enable positive teamwork

II. Basic Ground Rules

The following chart has been based on James Bellanca and Robin Fogarty's work on the different phases of social skills. (*Blueprints for Critical Thinking in the Cooperative Classroom*, Skylight Publishing, Inc., 1991, 2nd ed.)

Communication	**Trust**	**Responsibility**
Listen to your group members	Respect each others' opinions	Do your part
Use a 6" voice	Stay with the group	Help each other
Let all participate	Believe in each others' skills	Include all group members
Encourage others	Keep an open mind	Stay on task

III. The Research Project

Below are examples of the first steps you might want to take to begin the small group research project. We also suggest specifying the amount of time for each step, or at least checking-in with the groups after a designated amount of time. Providing a designated amount of time can help keep the students focused and 'on track'.

Step 1: Organize the small groups in to 2 – 4 individuals per group

Step 2: Pass out note-taking journals designated for this project (project journals).

Step 3: Establish the behavior guidelines–the ground rules. You may want to provide each student with their own copy of the ground rules (student hand-out #2) to secure in their project journal.

Step 4: Groups determine their project–1 mode of transportation + 1 time period. (10 minutes)

Step 5: Each individual in the group creates their own word map for the chosen topic. (5 mintues)

Step 6: The group members share their word maps within their group and create one word map. This will serve as either the outline for their process or as the basis for their outline. (Some students feel more comfortable with a more traditional style of outline). (10 minutes)

Step 7: Groups now analyze the collective word map and decide what are the most interesting aspects to everyone for the research project.

Step 8: Provide the five Focusing the Topic questions

1. How did the mode of transportation change over your selected time period (expanded, decreased, became more efficient or less efficient, became more expensive or less expensive, became more popular or outdated, etc.).

2. How is your chosen mode of transportation being used today or is it obsolete? In what parts of the world is the transportation being used?

3. How do you feel about the mode of transportation? Do you believe it should be increased, decreased, changed, re-designed, etc. in the world today? (Please be persuasive in your answer.)

4. Provide one visual–a drawing, photo, or sculpture–of your chosen mode of transportation at the beginning of your time period.

5. Provide one visual–a drawing, photo, or sculpture–of your chosen mode of transportation at the end of your time period.

Step 9: Groups develop Research Plan

- What–what kinds of research materials do they believe will be necessary & what type of resources are available to the group (books, internet, magazines, encyclopedias, etc.)?
- Where–where will they find the research materials?
- Who–who is interested in what part of the chosen topic?

(10 minutes)

Step 10: Groups develop Interaction Plan

- Who will be responsible for what part of the chosen topic?
- Will some of the parts be researched together?
- Create a timeline with specific goals at each aspect of the timeline (schedule)

(10 minutes)

Student Hand-out #1: 5 Goals

1. How did the mode of transportation change over your selected time period (expanded, decreased, became more efficient or less efficient, became more expensive or less expensive, became more popular or outdated, etc.).

2. How is your chosen mode of transportation being used today or is it obsolete? In what parts of the world is the transportation being used?

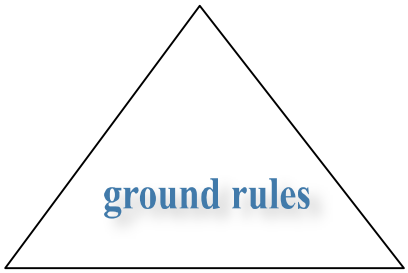
3. How do you feel about the mode of transportation? Do you believe it should be increased, decreased, changed, re-designed, etc. in the world today? (Please be persuasive in your answer.)

4. Provide one visual–a drawing, photo, or sculpture–of your chosen mode of transportation at the beginning of your time period.

5. Provide one visual–a drawing, photo, or sculpture–of your chosen mode of transportation at the end of your time period.

Student Hand-out #2: Ground Rules for Effective Small Group Projects

Trust
‡Respect each others' opinions
‡Stay with the group
‡Believe in each others' skills
‡Keep an open mind



Communication
‡Listen to your group members
‡Use a 6" voice
‡Let all participate
‡Encourage others

Responsibility
‡Do your part
‡Help each other
‡Include all group members
‡Stay on task

Lesson 5: 7th grade
Investigating Transportation
Step #2: Small Group Research Project Q & A

Lesson Overview: Exploring how transportation has changed over time.
Lesson Concept: People have been transporting materials for many years in many different ways around the world.

Materials:
- Note-taking journals

Standards
- Science:
  - I.1.MS.1 (Construct new Scientific and personal Knowledge: Generate scientific questions about the world based on observation).
- Social Studies:
  - IV.2.MS.4 (Economic Perspective: Examine the historical and contemporary role an industry has played and continues to play in a community).
  - VI.1.MS.3 (Public Discourse and Decision Making: Explain how culture and experiences shape positions that people take on an issue).

Timeline: 1 class periods (50 – 60 minutes)

Class Structure: whole class question & answer, and brainstorming session

Assessment Strategy: EEK! Daily Assessment
General Assessment Strategy #1
General Assessment Strategy #3

Lesson 5: 7th grade
Investigating Transportation
Step #2: Small Group Research Project Q & A

Lesson Overview: Exploring how transportation has changed over time.
Lesson Concept: People have been transporting materials for many years in many different ways around the world.

Materials:
- Note-taking journals

CLASS EXERCISES:

I. Discussing Problems

In order to help the students develop and create the most effective and interesting research projects, it is crucial to devote one full class period at some point during the middle of the research project schedule to field questions, challenges, and frustrations. This will help provide a check-in for you and the students, and provide the groups assistance.

The teacher's role within this full class discussion is to act as facilitator, not necessarily as the "one with the answers". This is an opportunity for the groups to ask questions to other groups and begin searching out their classmates to assist in solving problems rather than the teacher.

These problems or questions, though, should be relegated to issues around research questions and not stray into a personal session if group members are having difficulty between one another. Those issues might better be addressed personally with you in a non-public format.

The following are a few examples of questions you might want to ask the groups:

- How is the research going in general?
- Are you having any specific problems–not finding information, etc?
- Are you on schedule?
- Are any groups researching similar topics?
- How may I (the teacher) or others help you?

Lesson 6: 7th grade
Investigating Transportation
Step #3: Small Group Presentations

Lesson Overview: Exploring how transportation has changed over time.
Lesson Concept: People have been transporting materials for many years in many different ways around the world.

Materials:
- Note-taking journals
- Small group created project
- Student Hand-out: Organization and Ground Rules

Standards
- Science:
  - I.1.MS.1 (Construct new Scientific and personal Knowledge: Generate scientific questions about the world based on observation).
  - II.1.MS.3 (Reflect on the Nature, Adequacy and Connections Across Scientific Knowledge: Show how common themes of science, mathematics, and technology apply in real-world contexts).
- Social Studies:
  - II.5.MS.1 (Geographic Perspective: Describe how social and scientific changes in regions may have global consequences).
  - IV.2.MS.4 (Economic Perspective: Examine the historical and contemporary role an industry has played and continues to play in a community).
  - VI.1.MS.3 (Public Discourse and Decision Making: Explain how culture and experiences shape positions that people take on an issue).

Timeline: 1 - 2 class periods (50 - 60 minutes each) depending on the length of each presentation

Class Structure: small group presentations and class discussion

Assessment Strategy: EEK! Daily Assessment
General Assessment Strategy #1
General Assessment Strategy #2
General Assessment Strategy #3

Lesson 6: 7th grade
Investigating Transportation
Step #3: Small Group Presentations

Lesson Overview: Exploring how transportation has changed over time.
Lesson Concept: People have been transporting materials for many years in many different ways around the world.

Materials:
- Note-taking journals
- Small group created project
- Student Hand-out: Organization and Ground Rules

CLASS EXERCISES:

I. Culmination of the Project

The day has arrived–the culmination of the small group research project! Even if students have become deeply engaged in the research project, have developed positive, reflective, trusting relationships within their small group, and have created an insightful project, the public presentation may still be very difficult for many students.

In order to help facilitate a continued trusting environment where the students feel comfortable standing in front of the class and discussing their project, there are two specific issues we have found important to discuss with the class prior to the presentations: presentation organization and class ground rules.

II. Presentation Organization

Presentation organization is specifically how the group arrives at who will do what during the small group presentation. In order for their hard work to be understood and acknowledged, the group needs to be clear about what each member will be discussing. Below is a general outline of one way to help the groups organize their presentation materials.

A. Timed Presentations: Provide the groups with the presentation time maximum and minimum–for example, all group presentations need to be between 3 – 5 minutes.

B. Taking Turns: Even if one group member may feel inherently more comfortable speaking in front of the class than another group member, it is important to encourage all group members to directly participate in the presentation.

C. Get to the Point: Given that the presentations will have time limits, the groups need to develop a clear plan of how they will answer the target questions and present the visuals.

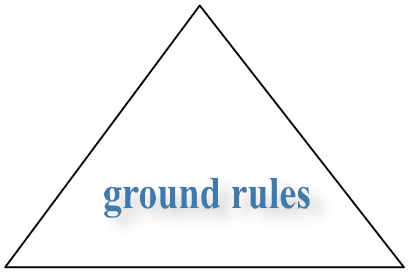
D. Stay on Track: Oftentimes, when middle school aged students become nervous, they begin laughing. Laughter, no matter the cause, can become infectious. Let students know ahead of time that the clock is ticking–if they waste their time they won't have an effective presentation.

E. Be Respectful: As an audience member, it is important to treat the presenters as you hope to be treated. Listen attentively, ask informed questions, do not interrupt, and be mindful of time constraints.

III. Presentation Ground Rules

These ground rules apply for the whole class during presentations–the presenters and the audience.

Trust
‡Respect each others' personal style
‡Don't make fun of anyone
‡Keep an open mind



Communication
‡Speak clearly
‡Stay focused
‡Answer questions at the end of the presentation
‡Wait your turn

Responsibility
‡Pay close attention
‡Ask informed questions
‡Include all group members

IV. Continuing the Transportation Timeline

Once each group presents their finished research project, add the new information on 18" x 24" pieces of colored cardstock or construction paper to the original Transportation Timeline. This can then place each research project into a larger context and provide a visual cue. We suggest using light colored pieces of cardstock to provide a visual signal to the spans of time that were more deeply researched.

Student Hand-out: Presentation Ground Rules

Small Group Organization

A. Timed Presentations: Provide the groups with the presentation time maximum and minimum–for example, all group presentations need to be between 3 – 5 minutes.

B. Taking Turns: Even if one group member may feel inherently more comfortable speaking in front of the class than another group member, it is important to encourage all group members to directly participate in the presentation.

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E. Be Respectful: As an audience member, it is important to treat the presenters as you hope to be treated. Listen attentively, ask informed questions, do not interrupt, and be mindful of time constraints.

Small Group Presentation Ground Rules

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‡Respect each others' personal style
‡Don't make fun of anyone
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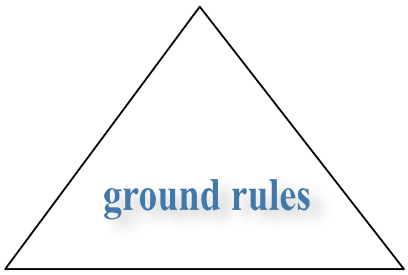


Communication
‡Speak clearly
‡Stay focused
‡Answer questions at the end of the presentation
‡Wait your turn

Responsibility
‡Pay close attention
‡Ask informed questions
‡Include all group members

Lesson 7: 7th grade
A Cursory Glance: Gasoline Production

Lesson Overview: Exploring how gasoline is located, mined, and made.
Lesson Concept: To better understand the process of how gasoline is made and gain a working knowledge of the level of resources necessary to turn crude oil into useable fuel.

Materials:
- Note-taking journals
- Gasoline Production Primer: How Gasoline is Made
- Student Hand-out: Question Set

Standards:
- English:
  - IX.11.MS.1 (Inquiry and Research: Define and investigate important issues and problems using a variety of resources).
- Mathematics:
  - III.1.MS.1 (Data Analysis & Statistics: Collect and explore data through observation, measurements, surveys, sampling techniques and simulations).
  - III.1.MS.4 (Data Analysis & Statistics: Identify what data are needed to answer a particular question or solve a given problem, and design and implement strategies to obtain, organize and present those data).
- Science:
  - I.1.MS.1 (Construct new Scientific and personal Knowledge: Generate scientific questions about the world based on observation).
  - II.1.MS.3 (Reflect on the Nature, Adequacy and Connections Across Scientific Knowledge: Show how common themes of science, mathematics, and technology apply in real-world contexts).
- Social Studies:
  - II.3.MS.4 (Geographic Perspective: Describe the major economic and political connections between the United States and different world regions and explain their causes and consequences).
  - II.5.MS.1 (Geographic Perspective: Describe how social and scientific changes in regions may have global consequences).
  - IV.2.MS.4 (Economic Perspective: Examine the historical and contemporary role an industry has played and continues to play in a community).
  - VI.1.MS.3 (Public Discourse and Decision Making: Explain how culture and experiences shape positions that people take on an issue).

Timeline: 1 class period (50 - 60 minutes) depending on the length of each presentation

Class Structure: reading assignment with class discussion

Assessment Strategy: EEK! Daily Assessment

Lesson 7: 7th grade
A Cursory Glance: Gasoline Production

Lesson Overview: Exploring how gasoline is located, mined, and made.
Lesson Concept: To better understand the process of how gasoline is made and gain a working knowledge of the level of resources necessary to turn crude oil into useable fuel.

Materials:

- Note-taking journals
- Gasoline Production Primer: *Gasoline Production: A Cursory Glance–from crude oil to gasoline*
- Student Hand-out: Question Set

CLASS EXERCISES:

I. Gasoline Production

This lesson requires the students to read the Primer– *Gasoline Production: A Cursory Glance–from crude oil to gasoline*–and brainstorm, either in small groups or individually, the review questions at the end of the Primer. In answering these questions, the students will be asked to create flow-charts to explain in a condensed format the basic gasoline production process and illustrate their answers.

II. Reading the Primer

The student hand-out can be found at the end of the lesson.

III. Interpreting the Reading

After the students have completed the reading, have them create gasoline production flow-charts based on the following set of 10 questions (the answers follow in red). Encourage the students to read through the entire set of questions before beginning.

Question Set:

1. What is gasoline created from?

Fossil remains–plants and animals that died 10 – 100 million years ago.

2. What is a definition of crude oil?

Unprocessed oil

3. What must happen to fossil remains in order for them to become crude oil or gas?

Extreme pressure and heat must be exerted on the source rock where the organic material reside.

4. Using your own ideas (do not copy from the reading hand-out), draw the process of how fossil remains become crude oil.

Various interpretations of the given illustrations and text

5. How might trapped crude oil be found?

Methods / tools that scientists may use to locate trapped oil are satellite imaging of surface terrain, gravity meters, magnetometers, core sample drilling, seismology, or sniffers.

6. What are three considerations that must be taken into account before an oil rig can be set up at a selected site?

Accessibility, water supply, and waste disposal

7. Illustrate what an identified site for drilling and an oilrig might look like.

Various interpretations of the Preparing to Drill for Oil section in images

8. Summarize through illustrations and captions (words) the oil refining process.

Through using their own images and language, distilling the information of the 3 Basic Steps: Separation, Conversion, and Treatment.

9. What is cracking and why is it important?

Cracking is the process of breaking larger hydrocarbons into smaller, lighter hydrocarbons. If the larger hydrocarbons are not broken into smaller hydrocarbons gasoline cannot be made. The boiling point of larger hydrocarbons is much higher than smaller ones. The boiling point of gasoline is fairly low–between 104° F and 401° F which requires smaller hydrocarbons.

10. What are 3 ways gasoline might be transported from the refinery.

Pipelines, ships, trains

Gasoline Production: A Cursory Glance–from crude oil to gasoline

Gasoline has been a focal point of conversation, policy decisions, and international relationships in the world for the past three decades. Our dependence on gasoline (and other petroleum products) may ultimately, be the deciding factor in changing the scope and character of our international relationships and quality of life across the United States. What is this substance that holds such vast power over American society and how is it created? This section provides a cursory glance at how crude oil is formed, found, mined, and transformed into gasoline.

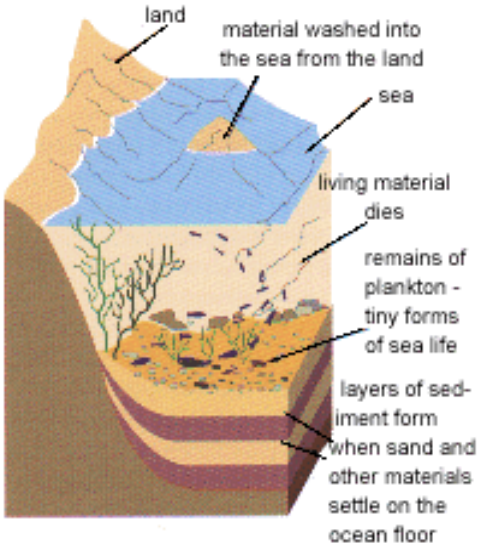
FOSSIL REMAINS

In order to create gasoline, crude oil–or unprocessed oil–must be located and extracted from deep inside the Earth. Crude oil is a non-renewable, natural resource called a fossil fuel. As the name suggests, it is formed from the remains of tiny plants and animals (plankton) that died millions of years ago–anywhere from 10 million to 600 million years ago.

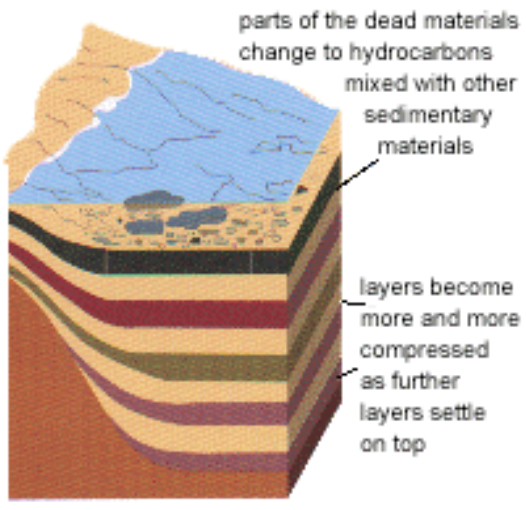
In this time period, much of the earth was covered with water (the ancient seas). Over millions of years, many layers of plankton remains, sand, and mud were formed on the ancient seabeds. Given there was little or no oxygen present in these layers, the plankton remains decayed into carbon-rich compounds. These compounds mixed with other sediment in the sea and formed fine-grained shale sedimentary layers. The early sedimentary layers are called source rock.

Over time, new sedimentary layers were formed and exerted pressure and heat onto the source rock layers below. Under extreme heat and pressure, the organic material found in the source rock became crude oil and natural gas. The crude oil then seeped from the source rock and accumulated in more porous limestone (shale + heat + pressure = limestone). The limestone layers are called reservoir rock. Movements in the Earth trapped the oil and natural gas in the reservoir rock between layers of very hard rock such as granite or marble. These layers are called cap rock.

Forming the Layers

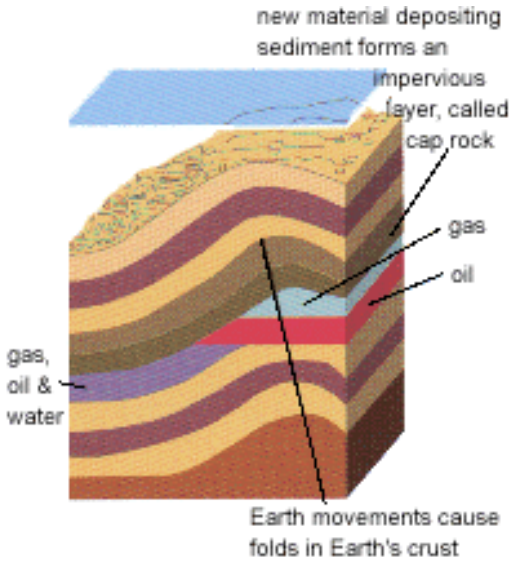


Compressing the Layers



images from School Science UK (www.schoolscience.co.uk/content/4/chemistry/fossils/p3.html)

Trapped Oil



LOCATING THE TRAPPED CRUDE OIL

Geologists are usually the scientists given the task of finding oil trapped deep within the Earth. Many methods are used to find the pockets of crude oil reservoirs. Today, satellite images help scientists to examine surface rocks and terrain. Scientists also use gravity meters that measure changes in the Earth's gravitational field possibly indicating flowing crude. Magnetometers that measure changes in the Earth's magnetic field are also used. Other methods / tools that scientists may use to locate trapped oil are core sample drilling, seismology, and sniffers.

Though modern oil exploration technology has become more sophisticated, there is still approximately a 10% success rate for locating new oil fields.

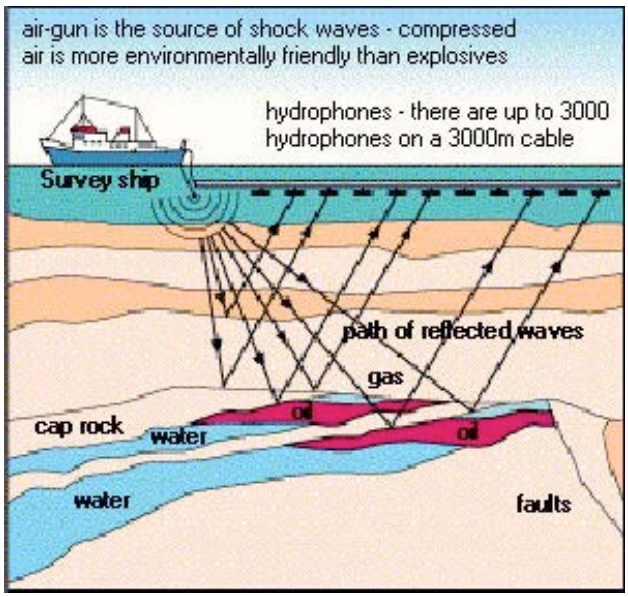


image courtesy from the article *How Oil Drilling Works* written by Craig C. Freudenrich, Ph.D

PREPARING TO DRILL FOR THE TRAPPED CRUDE OIL

Once a site has been selected for oil exploration, environmental impact studies and surveys must be completed. Land rights issues, access, and legal jurisdiction must also be settled before the actual drilling may begin.

Once these issues have been settled, the oil company begins preparing the site. These preparations may include:

- Clearing the land and building access roads;
- Drilling a water well if there is no water nearby;
- Digging a reserve pit where the drilling wastes (rock cuttings and drilling mud) are to be deposited; and,
- Building access roads and digging an off-site reserve pit if the drilling takes place in an ecologically sensitive area.

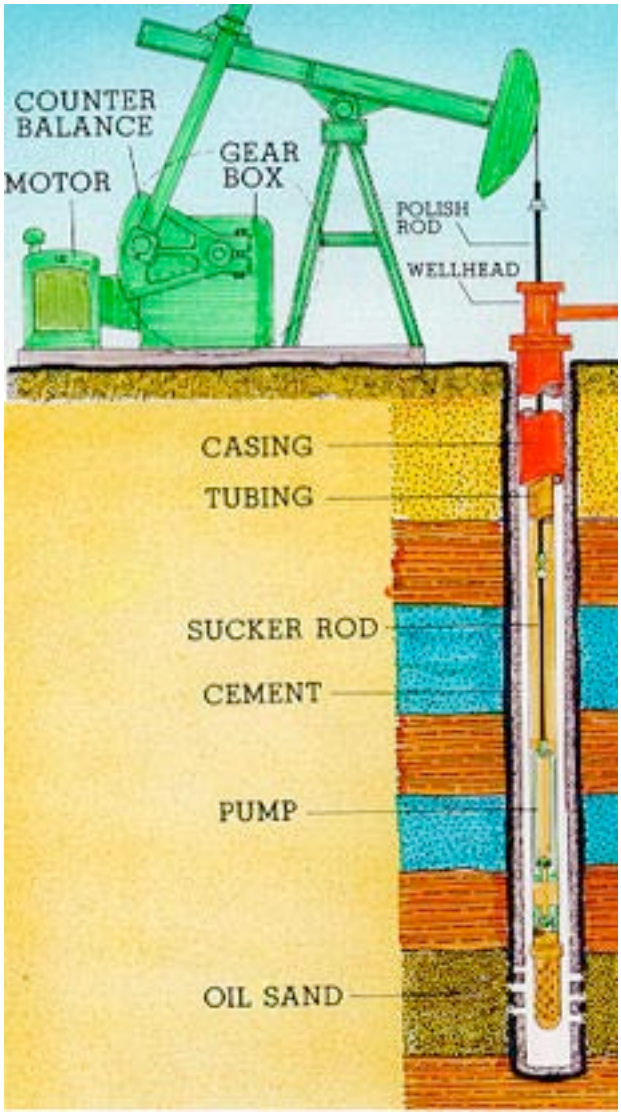
Once the site is prepared, the oil drilling rig must be built and several holes dug for the work crews and drilling apparatus. The drilling rig equipment and materials are then brought to the site by truck, helicopter, or barge-ship depending on the site location. Once the materials are in place, the oilrig is set-up.

Digging for oil is a large-scale operation and oilrig sites often resemble small cities. The oilrig not only contains all of the tools necessary for oil drilling and extraction, but it is also often the home for the crew. In most cases, oilrigs are in place for many years of drilling. Below is an image of a deepwater semi-submersible oilrig:

Sedco Energy & Sedco Express IHImage from:
www.btinternet.com/~derek.mackay/offshore/images/rigs/Twa_rigs_again.jpg

AN EXTREMELY SIMPLIFIED EXPLANATION OF CRUDE OIL EXTRACTION

Extracting the crude oil from inside the earth involves powering electrical generators from diesel engines to run the mechanical systems (drilling and hoisting systems). Deep shafts (wells) are drilled through the cap rock into the sedimentary layers containing the oil. A pump is moved up and down though the shaft creating a suction that draws oil up through the well. Below is an example of a pump on an oil well.



This detailed image is courtesy of the California Department of Conservation.

Photo courtesy of Phillips Petroleum Company

FROM CRUDE OIL TO GASOLINE: OIL REFINING

As we've learned thus far, crude oil that is pumped directly out of the ground is not the same thing as the oil used in a car's engine. Crude oil is a mixture of thousands of individual chemical compounds. In order to separate these compounds into useful materials (substances), the crude oil must be refined. There are three basic steps common to all oil refining operations: separation, conversion, and treatment.

But, before we discuss oil refining, it is important to note that the amount of gasoline–or kerosene, diesel oil, or other petroleum products–made from each barrel of crude oil depends on many factors and is not consistent from barrel to barrel of crude oil. Throughout the world, crude oil is sold by a 42-gallon barrel (barrel of crude oil equals 42 gallons). The conversion of crude oil to gasoline depends upon several factors such as: oil refinery production (it is not consistent from month to month); the quality of the crude oil; the type of gasoline (octane level) desired by the refinery; the international price per barrel (economic factors); and, the political stability of the region where the oil is being extracted. Therefore, it is difficult to gauge exactly how much gasoline can be made from each barrel of crude oil, though some experts will loosely estimate 40% of each barrel of crude is turned into gasoline. But, given the variety of factors determining gasoline production, please refer to the Energy Information Administration's website–eia.doe.gov–for up-to-date conversion percentages.

3 BASIC STEPS OF OIL REFINING: SEPARATION, CONVERSION, TREATMENT

FRACTIONAL DISTILLATION

One of the oldest and most common ways to separate molecules in liquid materials is through their boiling points. This method of distillation is also applied to separating crude oil. Crude oil contains many different chemical compounds that possess different boiling points. By heating the crude, the liquids and vapors can be separated into fractions according to their boiling points. Once the fractions reach their boiling point, the fractions will vaporize. Fractional distillation condenses the vapor.

FRACTIONAL DISTILLATION AND DISTILLATION TOWERS

Fractional distillation takes place in the distillation towers of an oil refinery. These are the tall, narrow columns that often give an oil refinery its distinctive appearance. Inside the towers, the liquids and vapors separate into fractions according to their density and boiling point. The lightest fractions rise to the top of the tower where they condense back to liquids, the medium weight liquids remain in the middle, the heavier liquids separate below, while the heaviest fractions with the highest boiling points settle at the bottom of the distillation towers.

www.sjgs.com/refinery.html

PRODUCTS PRODUCED FROM REFINED OIL FRACTIONS

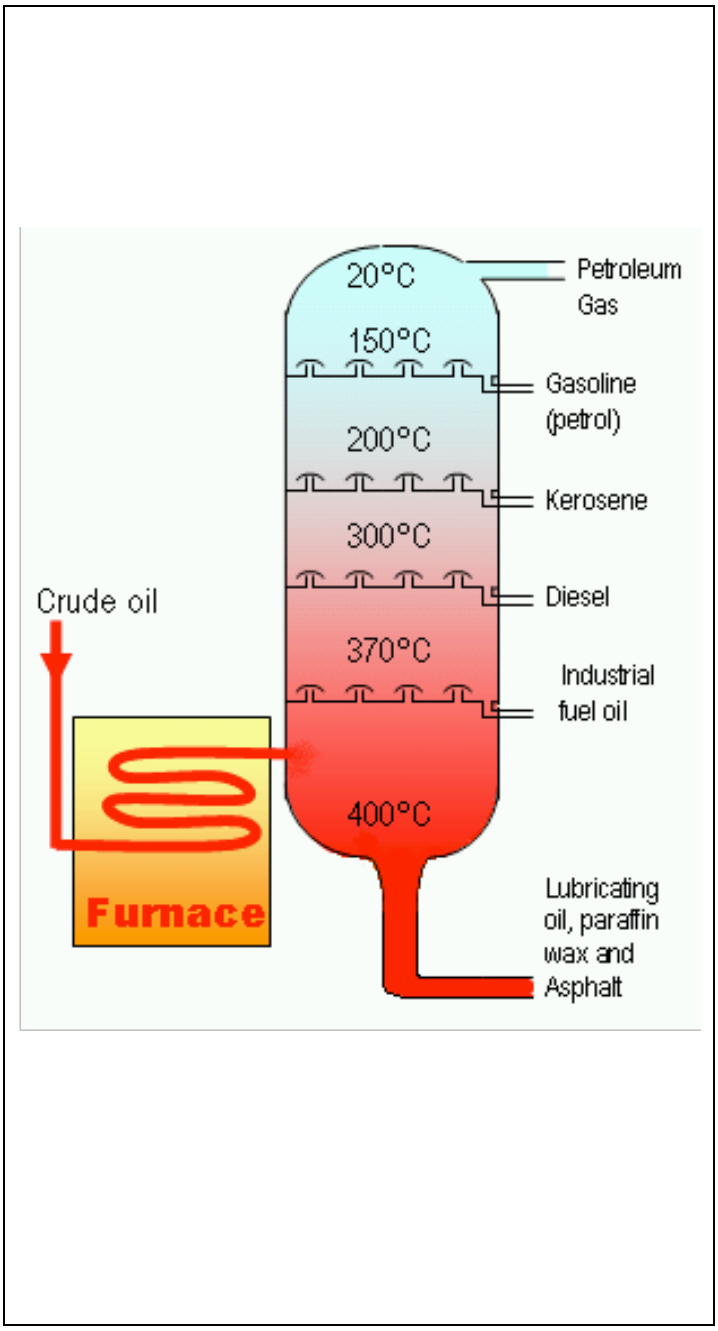


Image taken from Wikipedia from an article on Oil refinery
www.wikipedia.org

- Petroleum gas (used for heating, cooking, making plastics
  - Boiling range: less than 104°F
- Naptha or Ligroin (intermediate that will be further processed to make gasoline)
  - Boiling range: 140°F to 212°F
- Gasoline (motor fuel)
  - Boiling range: 104°F to 401°F
- Kerosene (jet / tractor fuel, starting material for other products)
  - Boiling range: 350°F to 617°F
- Diesel distillate (diesel fuel and heating oil, starting material for other products)
  - Boiling range: 484°F to 662°F
- Lubricating oil (motor oil, grease, other lubricants)
- Boiling range: 572° F to 700°F
- Fuel oil
  - Boiling range: 700°F to 1112°F
- Residuals (coke, asphalt, tar, waxes, starting material for other products)
  - Boiling range: greater than 1112°F

The listing of products was compiled from information from *How Oil Drilling Works* written by Craig C. Freudenrich, Ph.D. His article can be found at: www.science.howstuffworks.com/oil-refining.htm/printable. Also, please refer to the How Stuff Works website to view an animated drawing of a fractional distilling column.

CONVERSION

The various fractions are then piped to different stations within the refinery. Very few fractions leave the fractional distillation towers ready for market and many of them require chemical processing to transform them into other fractions. Conversion is where fractions are transformed into intermediate components that will eventually become the final products. The desired final product of the different fractions dictates the amount of additional processing that will be required. A fraction can be changed into another fraction by three different methods: cracking, unification, or alteration. But, we will focus on the 'gasoline-making' process of cracking.

Cracking is the general term for breaking larger hydrocarbons into smaller hydrocarbons. The larger hydrocarbons also have the highest boiling points. Therefore, in order to make gasoline, larger hydrocarbons must be transformed into smaller ones. (Gasoline molecules have from seven to eleven carbons in each hydrocarbon chain). The basic gasoline cracking process requires high heat, low pressure, and a catalyst. Depending on the octane level desired for the gasoline also dictates the amount of additional processing.

TREATMENT

This is the final stage of transforming crude oil into gasoline before it is loaded onto railroad cars and into tanker trucks to be delivered to gas stations across the nation. Impurities (such as sulfur, dissolved metals, nitrogen, water, and inorganic salts) are first removed and then refinery technicians blend fractions to make various grade gasolines–with or without performance additives–that meet governmental specifications.

The fractions that are not destined for becoming gasoline are also blended according to their desired product–lubricating oils of different weights (10W-40, 5W-30), various grades of kerosene, jet fuel, diesel fuel, heating oil, and various grade chemicals for plastics production.

Resources and Credits

The image used in the Conversion section is from the article *What is a Refinery? A Lesson in How to Make Gasoline*, www.sjgs.com/refinery.html

The image use in the Treatment section is from the book chapter, "Chemistry: Matter and Change", www.glencoe.com/sec/science/chemistry/mc/pow/chapter22.shtml

Excellent website resources for information on oil refinery are

- www.wpbschoolhouse.btinternet.co.uk/page04/OilProducts.htm#crude
- www.science.howstuffworks.com/oil-refining.htm/printable

Student Hand-out

Question Set:

1. What is gasoline created from?

2. What is a definition of crude oil?

3. What must happen to fossil remains in order for them to become crude oil or gas?

4. Using your own ideas (do not copy from the reading hand-out), draw the process of how fossil remains become crude oil.

5. How might trapped crude oil be found?

6. What are three considerations that must be taken into account before an oil rig can be set up at a selected site?

7. Illustrate what an identified site for drilling and an oilrig might look like.

8. Summarize through illustrations and captions (words) the oil refining process.

9. What is cracking and why is it important?

10. What are 3 ways gasoline might be transported from the refinery.